

## **UWB Tracking Software Development**

### **Abstract**

An Ultra-Wideband (UWB) two-cluster Angle of Arrival (AOA) tracking prototype system is currently being developed and tested at NASA Johnson Space Center for space exploration applications. This talk discusses the software development efforts for this UWB two-cluster AOA tracking system. The role the software plays in this system is to take waveform data from two UWB radio receivers as an input, feed this input into an AOA tracking algorithm, and generate the target position as an output. The architecture of the software (Input/Output Interface and Algorithm Core) will be introduced in this talk. The development of this software has three phases. In Phase I, the software is mostly Matlab driven and calls C++ socket functions to provide the communication links to the radios. This is beneficial in the early stage when it is necessary to frequently test changes in the algorithm. Phase II of the development is to have the software mostly C++ driven and call a Matlab function for the AOA tracking algorithm. This is beneficial in order to send the tracking results to other systems and also to improve the tracking update rate of the system. The third phase is part of future work and is to have the software completely C++ driven with a graphics user interface. This software design enables the fine resolution tracking of the UWB two-cluster AOA tracking system.

# **UWB Tracking Software Development**



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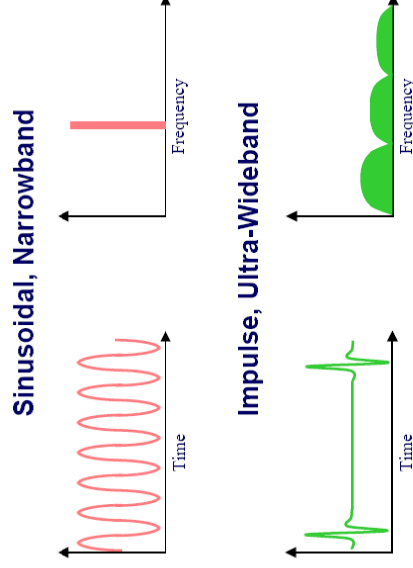


# Introduction

- An Ultra-Wideband (UWB) two-cluster Angle of Arrival (AOA) tracking prototype system is currently being developed and tested at NASA Johnson Space Center for space exploration applications.
- This talk discusses the software development efforts for this UWB two-cluster AOA tracking system.

# Introduction

- UWB is an emerging communications technology unlike traditional Continuous Wave (CW) narrow band systems. The technology was approved by FCC in February 2002.
- Features: High data rate, fine time resolution and low power spectral density.
- UWB system is used for communications with added passive tracking





# Overview

- Useful for tracking rovers and astronauts for early Lunar/Mars exploration missions when navigation systems (such as GPS) are not available
- SCOUT vehicle as test-bed for Lunar/Mars rover prototype
- Excellent tracking performance with less than 1% error at ranges up to 2000'



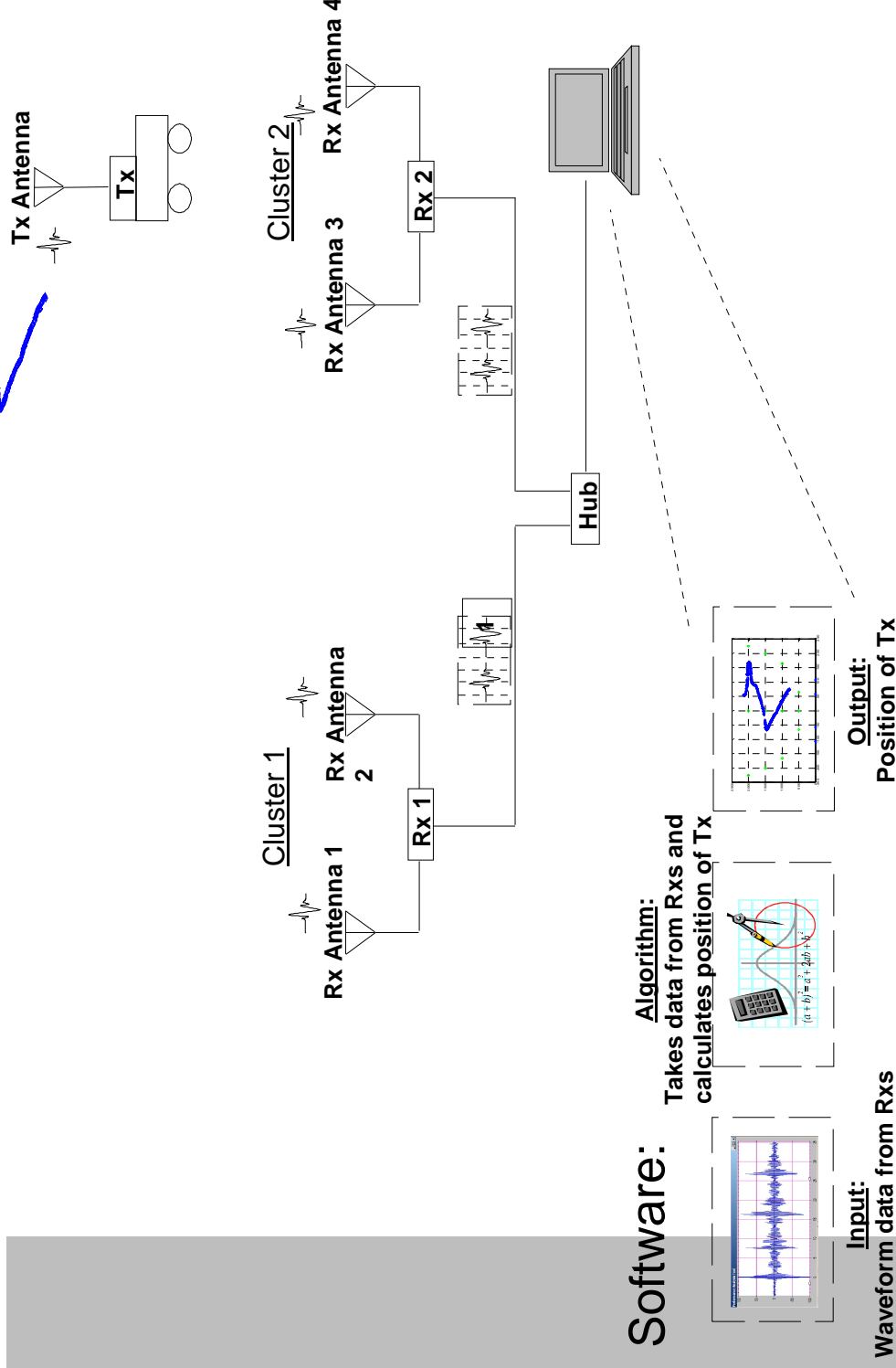


# Overview

- Utilize commercially available UWB radios and customize for our specific applications
- Radios are development kits and are not plug and play
- Radios essentially transmit and receive an UWB signal
- To use the radios:
  - Develop the Algorithm
  - Develop the Software
  - Develop the Hardware



# Functionality of the UWB Tracking Software





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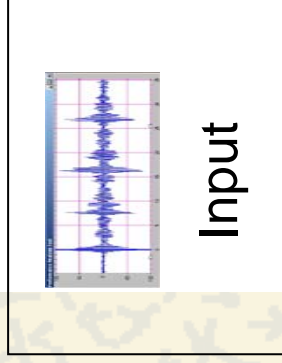
- Goal is to track the position of the rover
- A transmitter and an antenna are located on the rover
- Four antennas, two receivers, a hub, and a laptop at the base station
- Base station is divided into two clusters, each with two antennas and one receiver
- The role the software plays in this system is to take waveform data from two UWB radio receivers as an input, feed this input into an AOA tracking algorithm, and generate the target position as an output.



# Architecture of UWB Tracking Software

Input:

Waveform data from Rx's

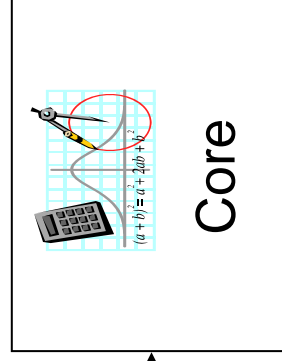


Waveform data

Input

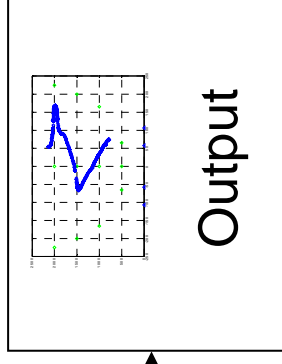
Core:

Algorithm takes data from Rx's and  
calculates position of Tx



Position data

Output:  
Position of Tx



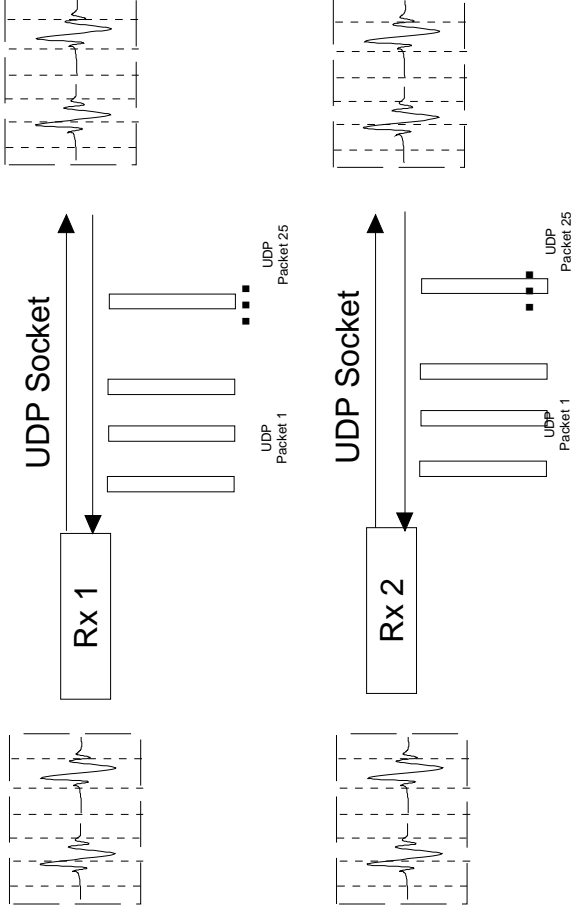


# Architecture of UWB Tracking Software

- The architecture of the software includes the Input/Output Interface and the Algorithm Core.
- Input:
  - Waveform data containing timing information received from four antennas
- Core:
  - AOA tracking algorithm
  - Extracts timing information from waveform data and calculates position of transmitter
- Output:
  - Converts the position data into GPS coordinate system to track rover
  - Plots and displays the position data to show accuracy of the system

**Input:**

# Parallel Multi-Socket Programming

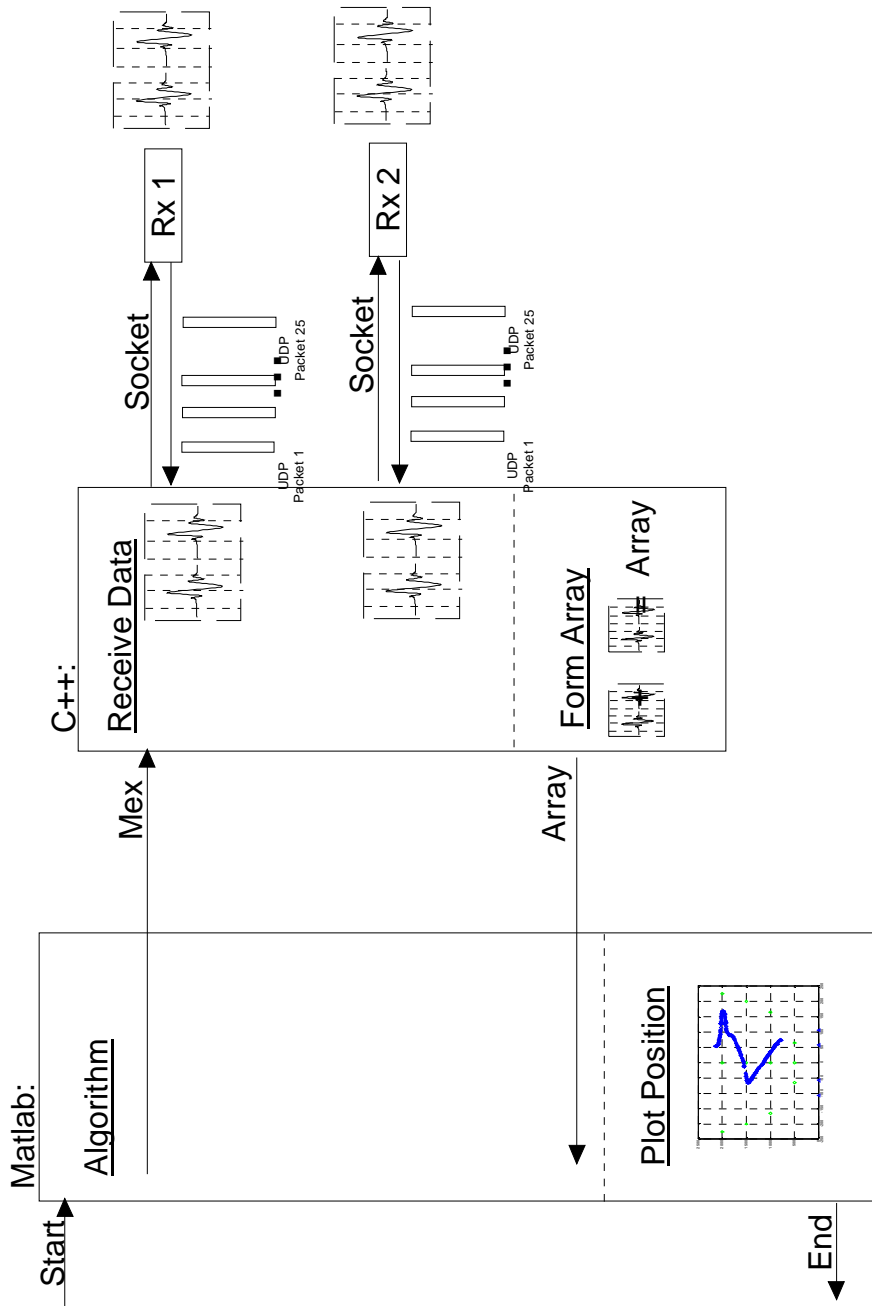




# Input: Parallel Multi-Socket Programming

- Waveform data is divided into 25 segments at radio
- Software has a separate UDP socket for each of the two radios
- Software collects one segment from one socket from receiver 1 and then takes one segment over the other socket from receiver 2
- This alternating process is repeated until a complete waveform is assembled from each radio
- The two radio are not synchronized. This process allows the collection and assembly of the waveforms at approximately the same instant in time to ensure the accuracy of the system

# Phase I of UWB Tracking Software Development





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- The software is Matlab driven with a C++ portion
- The C++ part of the program is a Matlab Mex function which treats the C++ portion as if it were just a Matlab function
- Matlab uses C++ to provide the communication links to the radios via UDP sockets
- Beneficial in the early stage when it is necessary to frequently test changes in the algorithm, better to use Matlab
- Drawbacks are the efficiency of opening and closing the sockets on each loop in Matlab – Also, plotting in Matlab takes up time

# Phase II of UWB Tracking Software Development

